

ACCESSION #: 9312140176
LICENSEE EVENT REPORT (LER)

FACILITY NAME: McGuire Nuclear Station, Unit 1 PAGE: 1 OF 9

DOCKET NUMBER: 05000369

TITLE: Unit 1 Reactor Trip/Turbine Trip On Over Temperature
Delta Temperature Resulting From An Equipment Failure
(Inadvertent Action) Of The Emergency Trip Solenoid Due
To An Unknown Cause.

EVENT DATE: 11/06/93 LER #: 93-09-0 REPORT DATE: 12/06/93

OTHER FACILITIES INVOLVED: N/A DOCKET NO: 05000

OPERATING MODE: 1 POWER LEVEL: 100%

THIS REPORT IS SUBMITTED PURSUANT TO THE REQUIREMENTS OF 10 CFR
SECTION:
50.73(a)(2)(iv)

LICENSEE CONTACT FOR THIS LER:

NAME: Terry L. Pedersen, Manager TELEPHONE: (704) 875-4487

COMPONENT FAILURE DESCRIPTION:

CAUSE: X SYSTEM: LH COMPONENT: PSV MANUFACTURER: P070
REPORTABLE NPRDS: Y

SUPPLEMENTAL REPORT EXPECTED: NO

ABSTRACT:

On November 6, 1993, at 0220:14, while operating in Mode 1 (Power Operation) at 100 percent power, Unit 1 experienced a Reactor Trip/Turbine Trip on Over Temperature Delta Temperature (OTDT). The initiating event was a large loss of turbine load caused by Turbine Governor and Interceptor Valve closure. The unit was stabilized in Mode 3 (Hot Standby) and an investigation into the cause of the valve closure was conducted. While a suspected cause was developed, it could not be confirmed. A decision was made to proceed with restart, and continue testing circuits monitoring generator and switchyard breaker position. During restart, a problem with the Interceptor valves was discovered. Both the Overspeed Protection Control (OPC) solenoid valves and a Train B Emergency Trip (ETC) solenoid valve were replaced and the Unit was returned to Mode 1 at 0405 on November 7, 1993. This event has been assigned a cause of Equipment Failure/Malfunction due to an unknown

cause. Immediate corrective actions were to replace the three solenoid valves associated with the OPC header prior to returning the unit to service. Planned corrective actions include an evaluation of potential changes to the flush methods used on the Electro-Hydraulic High Pressure Fluid system. Also an evaluation of possible equipment modifications/replacements will be performed in conjunction with other problems identified with the OPC and ETC solenoid valves.

END OF ABSTRACT

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EVALUATION:

Background

The Overtemperature Delta Temperature (OTDT) trip is one of nineteen Reactor [EIIS:RCT] trip inputs associated with the Reactor Protection (IPE) system [EIIS:JC]. It protects the core against Departure from Nucleate Boiling (DNB) and causes the Reactor to trip when 2 out of 4 channels [EIIS:CHA] exceed the setpoint. The OTDT trip setpoint is variable depending on the average Reactor Coolant temperature (T-ave), Pressurizer [EIIS:PZR] pressure, and axial flux difference (AFD). The setpoint provides protection against DNB over a range of temperatures and pressures. The OTDT trip setpoint is continuously calculated by solving an equation given in Technical Specification (TS) Table 2.2-1, Reactor Trip System Instrumentation Trip Setpoints.

The Main Turbine Instrumentation and Control (ITE) system [EIIS:JJ] utilizes a redundant set of solenoid valves [EIIS:PSV] in the Electro-Hydraulic High Pressure Fluid (LH) system [EIIS:TG] for overspeed protection control (OPC). When the turbine speed is greater than a preset initialized value of 103 percent, or when the load is greater than 22 percent and the generator separates from the grid, the controller will initiate closing of the Governor [EIIS:65] and Interceptor valves. This OPC header is depressurized by energizing OPC solenoid valves 20-1/OPC (1LHSV0190) AND 20-2/OPC (1LHSV0200) causing them to open and dump the hydraulic control fluid from the OPC header. Separation from the grid will also switch the Condensate (CM) [EIIS:KA] system to full load rejection mode if the turbine load is greater than 50 percent.

In addition to the two OPC solenoid valves, there is another valve on the OPC header. This valve is the Train B Emergency Trip (ETC) solenoid valve, 20/ETC (1LHSV1430). The ETC solenoid valve will dump the hydraulic control fluid from the OPC header and trip the turbine upon receipt of a signal from the Reactor Trip Breakers, Safety Injection

system, Steam Generator HI-HI Level switch, and Auto Stop Oil Pressure switch. The 20/ETC solenoid valve is wired in parallel with the 20/ET solenoid valve; therefore, an electrical signal will energize both 20/ET and 20/ETC. This will cause the Throttle and Reheat Stop valves as well as the Governor and Interceptor valves to close.

Description of Event

On November 6, 1993, at 0220:04, Unit 1 was operating in Mode 1 (Power Operation) at 100 percent when the Main Turbine (MT) [EHS:TRB] Governor valves and Interceptor valves closed unexpectedly with no prior warning. The Reactor Operator at the Controls (ROATC) heard various alarms and observed the Control Rods stepping into the core at a high rate.

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The ROATC saw a large power mismatch. He then scanned the boards and did not see any indication of a Turbine runback signal. He placed the rods in manual, suspecting a possible instrument failure. Almost immediately he returned the rods to automatic and they began to step in again. The Reactor OTDT setpoint was reached at 0220:14.165. The Reactor Trip Breakers opened at 0220:14.279. Operations personnel entered Emergency Procedure EP/1/A/5000/01, Reactor Trip or Safety Injection. subsequently Operations personnel transitioned to EP/1/A/500/1.3, Reactor Trip. The primary and secondary plant parameters were stabilized at no load conditions within 30 minutes following the trip. The Unit was stabilized in Mode 3 (Hot Standby) with no significant problems. The required 4 hour notification to the NRC was made at 0315 in accordance with Procedure RP/0/A/5700/10, NRC Immediate Notification Requirements.

Work Order 93080066 was originated to have Instrumentation and Electrical (IAE) personnel troubleshoot the cause of the Governor valve closure. since all Governor valves and Interceptor valves closed at the same time, the most likely cause of the trip was a depressurization of the OPC header. The original focus of the trip investigation was on an inadvertent electrical signal. This was due to several reasons. 1) The belief that the OPC and ETC solenoid valves could not fail open without an electrical signal. 2) The Megawatt Feedback Loop was removed from service. 3) A Runback alarm was not received. 4) The Condensate System went into Full Load Rejection mode. The ETC solenoid valve was ruled because the Throttle valves and Reheat Stop valves did not close and there had been no indication of an electrical signal on the ETC solenoid valve. For these reasons, the scope of the investigation was then narrowed to an electrical malfunction of the OPC circuits.

Analysis of the data taken during the trip indicated there had been no

switchyard or generator breaker operation or indications of control malfunction from the alarm [EHS:ALM] typer. The investigation then focused on relays [EHS:RLY] monitoring the Generator and Switchyard Breakers. If these relays had de-energized a signal would have been generated to trip the OPC header. This would close the Governor and Interceptor valves and prevent a possibility of an overspeed condition. These two relays, GBX and GBX1, are in parallel. Both relays would have to de-energize for the OPC circuit to function.

The entire circuits for GBX and GBX1 were hand traced looking for loose connections, grounds, bad relays, etc. On B-Busline, a nut was found missing on terminal K-329 in the Generator Breaker 1B Control Panel. The wire had been placed on the terminal stud, but was loose. The nut was replaced and the rest of the circuit checked. No further problems were found. Since the problem found could not have caused the trip by itself, attention was then directed toward the circuit for A-Busline. A loose connection was found on terminal B-37 in 1ATC28. The potential failures were tested to try and recreate a

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malfunction of the GBX relays. The malfunction could not be repeated. Personnel investigating the cause of the failure consulted with Operations and Engineering personnel. These problems could have caused the failure. However, since the circuits are in parallel, it was highly unlikely that both circuits de-energized at the same time thus causing the trip.

At 1315 on November 6, 1993, personnel from Operations, Reactor Engineering, Component Engineering (responsible for the ITE System), met with the Station Manager to discuss the decision to restart. The decision was made to commence reactor start-up and hold at Mode 2 (Startup) until further troubleshooting of the OPC circuits could be completed.

IAE completed their troubleshooting of the OPC circuits later that day without finding any conclusive evidence as to the cause of the solenoid actuation. Operations personnel tested the Generator Breaker operation. The circuits monitoring breaker indication functioned properly. Operations staff consulted with the Station Manager and a decision was made to restart the unit while continuing to analyze the trip data to determine a more plausible reason for the trip.

At 2000 on November 6, 1993, Operations personnel attempted to latch the Main Turbine in preparation for start-up. The Interceptor valves would not open indicating a failure to build OPC pressure. Work Order 93080090

was issued to investigate why the OPC solenoid valves had not closed. Both OPC solenoid valves (1LHSV0190 and 1LHSV0200) were replaced, but did not correct the problem. The Train B ETC solenoid valve was then replaced and the Interceptor valves were able to open. The unit was then returned to Mode 1 at 0405 on November 7, 1993.

Conclusion

A cause of Equipment Failure has been assigned to this event because the OPC header pressure was unable to be maintained. The cause of the solenoid valve malfunction can not be conclusively determined. The original belief was that the solenoid valves associated with the OPC header could not have failed mechanically during normal operation and caused the trip. The ETC solenoid valve malfunction that was found during attempts to latch the Turbine to perform further testing, was thought to be similar to a problem identified on Problem Investigation Program (PIP) report 1-M93-0965 and not related to the trip. The ETC solenoid valve that was replaced on November 7, 1993, was taken to Servocon on November 10, 1993, for inspection and testing. No problems were found with the function of the solenoid valve.

After analyzing how the OPC relief valve worked, a theory as to the failure mode was

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identified. The theory was that this valve could have failed due to a clog in a small orifice in the main relief spool and/or excessive leakage in the pilot valve spool (See the sketch on page 9). Prior to this event this type of failure had not been identified or considered. Parker Hanifin company confirmed that a blockage of the bleed orifice on the main relief spool, could have caused a mechanical failure.

Further analysis of the trip data showed that an electrical signal actuating the OPC circuit would have also immediately initiated a condensate full load rejection signal. The full load rejection signal was not received until 12 seconds after the Governor valves and Interceptor valves had closed and occurred when an OTDT runback was generated. This was just prior to the Reactor trip. The Megawatt Feedback Loop was automatically removed from service due to the zero megawatt output from the generator. These facts contributed to the elimination of the possibility that an electrical problem caused the GBX relays to de-energize and further supported the theory that a mechanical failure had to have caused the trip.

A review of the Operating Experience Program (OEP) Database for the

twenty-four months prior to this event revealed several Reactor Trips or Turbine Trips in which the cause was equipment failure. However, there were none that involved a failed OPC solenoid valve. Therefore, this event is not considered recurring. However, an event that occurred on October 5, 1993 and documented on PIP 1-M93-0965 involved a failure of these same solenoid valves and is still under investigation. Preliminary findings indicate a link to possible contamination of the hydraulic oil. Information obtained from that event and the event that occurred on November 6, will be used to determine if additional corrective actions are necessary.

This event is Nuclear Plant Reliability Data System (NPRDS) reportable, due to the failure of the OPC solenoid valve maintaining its desired position.

There were no personnel injuries, radiation overexposures, or uncontrolled releases of radioactive material resulting from this event.

CORRECTIVE ACTIONS:

Immediate: 1) Operations personnel implemented procedure EP/1/A/5000/01, Reactor Trip or Safety Injection.

Subsequent: 1) Work Control personnel originated Work Order 93080066 to troubleshoot and repair the Unit 1 Turbine Controller Operator.

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2) IAE personnel investigated the cause of the inadvertent operation of the OPC solenoid valves.

3) Operations personnel tested the generator breakers operation and the function of circuits monitoring breaker position.

4) IAE personnel replaced the OPC solenoid valves and Train B Emergency Trip solenoid valve.

5) Engineering personnel worked with Servocon to test the Train B Emergency Trip solenoid valve.

Planned: 1) Engineering personnel will have the two OPC solenoid valves tested and will evaluate the test results for other potential causes. . .

2 Engineering personnel will evaluate the flushing methods used on the LH system and will implement improvements identified.

3) Engineering personnel will use information obtained from this event and the event documented on PIP 1-M93-0965 to evaluate the need for modifications or replacements to the solenoids valves.

4) Operations personnel will emphasize to all licensed personnel, the importance of correctly assessing the situation prior to taking manual control of the Control Rods.

SAFETY ANALYSIS:

When the Unit 1 Turbine Governor and Interceptor Valves closed, there was an immediate power mismatch between the Turbine Load and Reactor Power. The Rod Control System (IRE) [EIS:RE] attempted to compensate for the mismatch by inserting the Control Rods as designed. The ROATC placed the IRE system in manual in an attempt to prevent a Unit transient due to an instrument failure. This action was non-conservative; however, the system was only in manual for a few seconds and had little if no affect on the other actions of the unit's control systems. The reactor coolant temperature continued to rise. As the delta-T approached 3 percent of the OTDT Reactor trip setpoint, the CM system switched to full load rejection mode as required. When the delta-T exceeded the OTDT trip setpoint, the unit experienced a Reactor Trip. This Reactor Trip input protects the core against DNB and causes the Reactor to trip when 2 out of 4 channels exceed the setpoint. From a standpoint of Reactor safety, the unit responded as required. All required systems and components functioned as designed to mitigate the consequences of this event.

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The health and safety of the public and plant personnel were not affected as a result of this event.

Additional Information

Sequence of Events:

AT - Alarm Typer

ER - Events Recorder

SRO - Unit 1 Senior Reactor Operator Log Book

TM - Transient Monitor

Date Time Event

11/06/93 0220:04 Governor Valves and Interceptor Valves all closed.(AT)

0220:06 Generator Megawatts less than 0.5 percent.(TM)

0220:06.562 DEH automatically removed the megawatt loop from service due to megawatts less than 0.5 percent.(ER,TM)

0220:06 1B LH pump automatically started due to LH pressure decreasing to 1500 PSIG.(AT)

0220:13 Loop delta T's within 3 percent of OTDT trip setpoints.(TM)

0220:14.165 OTDT Reactor Trip signal generated.(ER)

0220:14.214 Condensate system in full load rejection mode.(ER)

0220:14.268 Reactor Trip Breaker 1A open. (ER)

0220:14.279 Reactor Trip Breaker 1B open.(ER)

0220:14.366 Turbine Trip.(ER)

0220:14.402 NIS flux rate trip.(ER)

0220:14.509 Generator PCB 1A Open.(ER)

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DATE TIME EVENT

0220:14.512 Generator PCB 1B Open.(ER)

2000:00 Attempted to latch turbine.(SRO)

11/06/93 2230:00 Replaced OPC solenoid valves.(SRO)

11/07/93 0320:00 Replaced ETC solenoid valve.(SRO)

0405:00 Entered Mode 1.(SRO)

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Figure omitted.

ATTACHMENT TO 9312140176 PAGE 1 OF 2

Duke Power Company T. C. McMEEKIN
McGuire Nuclear Generation Department Vice President
12700 Hagers Ferry Road (MG01A) (704) 875-4800
Huntersville, NC 28078-8985 (704) 875-4809 FAX

DUKE POWER

December 2, 1993

U. S. Nuclear Regulatory Commission
Document Control Desk
Washington, D.C. 20555

Subject: McGuire Nuclear Station Unit 1
Docket No. 50-369
Licensee Event Report 369/93-09
Problem Investigation Process No.: 1-M93-1145

Gentlemen:

Pursuant to 10 CFR 50.73 Sections (a) (1) and (d), attached is Licensee Event Report 369/93-09 concerning a reactor trip on OTDT resulting from an equipment failure (actuation) of the Emergency Trip Solenoid due to an unknown cause. This report is being submitted in accordance with 10 CFR 50.73 (a) (2) (iv). This event is considered to be of no significance with respect to the health and safety of the public.

Very truly yours,

T. C. McMeekin

TLP/jca

Attachment

xc: Mr. S. D. Ebnetter INPO Records Center
Administrator, Region II Suite 1500
U.S. Nuclear Regulatory Commission 1100 Circle 75 Parkway
101 Marietta St., NW, Suite 2900 Atlanta, GA 30339

Atlanta, GA 30323

Mr. Victor Nerses Mr. George Maxwell
U.S. Nuclear Regulatory Commission NRC Resident Inspector
Office of Nuclear Reactor Regulation McGuire Nuclear Station
Washington, D.C. 20555

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bxc: B. L. Walsh
R. C. Futrell (CNS)
P. R. Herran
R. C. Norcutt
M. E. Patrick (ONS)
G. H. Savage
G. B. Swindlehurst
H. B. Tucker
R. F. Cole
D. B. Cook
G. A. Copp
C. A. Paton
M. E. Pacetti
P. M. Abraham
NSRB Support Staff (EC 12-A)

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